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REVISED CLASSIFICATION OF THE UPPER PALEOZOIC FORMATIONS OF KANSAS.

CONTENTS.

INTRODUCTION.

IN 1895 the writer published a paper on "The Classification of the Upper Paleozoic Rocks of Central Kansas" in the JOURNAL OF GEOLOGY.[1] Additional field work and study of the Cottonwood Falls quadrangle render it advisable, in compliance with the custom of the United States Geological Survey to designate each lithologic individual capable of representation on the topographic map as a formation, to subdivide three of the units which were described as formations in that article.

A few changes in classification or nomenclature have been made which are also explained in this paper. Dr. J. W. Beede,

[1] Vol. III, pp. 682–706, and pp. 764–801.

of Indiana University, who has been associated with the writer in this later study, has rendered most efficient service in the field and other work necessary for this revision. Dr. George I. Adams, of the United States Geological Survey, spent several days with Dr. Beede in examining part of the area of the Cottonwood Falls quadrangle, and Mr. F. B. Weeks has also kindly furnished the author with references to the descriptions of formations from the United States Survey card catalogue of geologic formation names.

CLASSIFICATION.

WABAUNSEE STAGE.[1]

None but the upper rocks of this stage are exposed on the Cottonwood Falls quadrangle and the lower ones, exposed to the eastward, have not been carefully examined by the writer.

Burlingame limestone.—At the base of the Wabaunsee is a conspicuous and persistent limestone from seven to twelve feet in thickness, the lower limit of which is regarded as the lower line of that stage. It was named and briefly described by Hall in 1896[2] from outcrops near Burlingame and since then it has been traced from Nebraska across the state to Oklahoma.[3]

This limestone is frequently composed of two layers, gray to brown in color, separated by shale, and forms a massive ledge. This is apparently the division which was termed "limestone number 9" by Professors Haworth and Kirk, in 1894, exposed near the junction of the Cottonwood and Neosho rivers, which they stated "may be called the *Wyckoff limestone* . . . . on account of its great exposure in the vicinity of Wyckoff.[4]" This name, however, ought to be considered a synonym, for Dr. Sardeson had already given an almost identical one to a division of

[1] The word stage is used in the sense adopted by the International Congress of Geologists. See *Work Inter. Cong. Geologists*, 1886, p. 50; GILBERT, in *Proc. A. A. A. S.*, Vol. XXXVI, 1888, p. 186; Congrés Géologique International (8e Session), *Procès-verbaux des Séances*, 1901, p. 35; and *ibid.*, *Comptes Rendus*, 1er Fasc., 1901, p. 196.

[2] *Univ. Geol. Surv. Kansas*, Vol. I, p. 105.

[3] See, "Map of Limestone Outcroppings," by PROFESSOR HAWORTH, Vol. III, *Univ. Geol. Surv. Kan.*, 1898, Pl. VII.

[4] *Kan. Univ. Quart.*, Vol. II, Jan. 1894, p. 111.

CLASSIFICATION OF THE UPPER PALEOZOIC FORMATIONS OF KA

- Permian system. (?)
  - Cimarron series[2] - Cragin, '96.
    - Kiger Stage[1] - Cragin, '96.
      - Taloga formation-
      - Day Creek dolomite
      - Red Bluff formation
    - Salt Fork Stage - Cragin, '96.
      - Dog Creek formation, Cragin, '96. { Cha / Am
      - Cave Creek formation, Cragin, '96. { Shir / Jenk / Mec
      - Glass Mountain formation, Cragin, '97. { Flo / Ced
      - Kingfisher formation, Cragin, '97. { Salt / Har
  - Big Blue series[3] - Cragin, '96.
    - Summer Stage - Cragin, '96.
      - Wellington shales[7]
      - Marion formation
    - Chase Stage - - - Prosser, '95.
      - Winfield formation
      - Doyle shales
      - Fort Riley limestone
      - Florence flint
      - Matfield shales
      - Wreford limestone
- Carboniferous system (upper part only). (?)
  - Missourian Series[4] - Keyes, '96. (Upper part of series)
    - Council Grove Stage.
      - Garrison formation, Prosser and Beede. { Neo / Flor
      - Alma limestone
    - Wabaunsee Stage - Prosser, '95.
      - Eskridge shales
      - Neva limestone
      - Elmdale formation
      - Americus limestone
      - ——— formation
      - Emporia limestone
      - ——— shales
      - Burlingame limestone

[1] The classification of the formations from the top of the Kiger to the Wellington shales, inclusive, is that of Dr. Cragin, except that he termed Kiger and Salt Fork *divisions* of the Cimarron series (*Col. Coll. Studies*, Vol. VI, March 27, 1896, pp. 3, 16-49). The following year Dr. Cragin revised the classification of the Cimarron series, changing the limits and names of some of the formations and drawing the line of separation between the Salt Fork and Kiger divisions at the *top* of the Dog Creek formation instead of at its *base*, as in the former classification (*Am. Geol.*, Vol. XIX, May, 1897, pp. 351-64).

[2] *Col. Coll. Studies*, Vol. VI, pp. 3, 18, 48; and see additional account in *Am. Geol.* Vol. XIX, May, 1897. pp. 351-64.

[3] *Col. Coll. Studies*, Vol. VI, March 27, 1896, pp. 3, 5, 6. In July, 1896, Dr. Keyes proposed "to recognize in the 'upper' Carboniferous of the Western Interior province three series having equal taxonomic rank," the upper one of which was named the "Oklahoman" (*Am Geol.*, Vol. XVIII, p. 25). In defining the series it was stated that "In suggesting the name 'Oklahoman' as a serial geological term it is intended to apply to all those rocks of Carboniferous age which occur north of the Canadian river in Oklahoma, and which lie between the interval of the top of the Missourian series and the base of the Cretaceous. It may be regarded as essentially covering the same succession of strata that has long been vaguely known under the title of 'Permian.' The name is derived from the territory in which the formation has its best development and in which the most complete sequence is represented" (*ibid.*, p. 27). In October, 1891, Dr. Keyes recognized the Cimarron series and gave the Oklahoman and Cimarron as the two closing series of the Carboniferous (*Am. Jour. Sci.*, 4th ser., Vol. XII, pp. 306, 309), stating that "The so-called Permian of the Western Interior basin (Oklahoman and Cimarron, the latter generally known as the Red Beds) is composed largely of shales and shaly sandstones. . . . . The conditions existing were identical with those under which the original Permian beds of Russia were formed" (*ibid.*, p. 309). The following month Dr. Keyes published a "General Geological Section of the Carboniferous of the Mississippi Valley," in which a complete list of the series and terranes of the system is given. For the portion under consideration it is as follows:

	Series.	Terranes.
Carboniferous system (upper portion).	Cimarron	Kiger shales.
		Salt Fork shales.
	Oklahoman	Wellington shales.
		Marion limestone.
		Chase limestone.
		Neosho shales.
	Missourian (upper part)	Cottonwood limestone.
		Atchison shales.

(*Am. Geol.* Vol. XXVIII, p. 302.) It will be seen that defined above is identical with the Big Blue series pr therefore his name, which has priority, is adopted for this only change from Professor Cragin's classification of the member at its base is put in the Missourian series. The in 1902 (*Twenty-first Ann. Rept. U. S. Geol. Surv.* apparently the same as the Cimarron series of Cragin.

[4] "Missourian" was proposed as the name of a (*Am. Geol.*, Vol. XVIII, pp. 25-27). This was an out mation which was proposed by him in 1893 (*Iowa G Mon. Rev. Iowa Weather Service*, Vol. IV, p. 3).

[5] Nearly three years later Professor H. S. Willia stone" to a formation occurring in northeastern Maine 1900, Vol. IX, pp. 203, 205, which was more fully descri 165, 1900, p. 78).

[6] It is not probable that "Harper sandstone" ca because the very similar term of "Harper's shale" was as the name of a formation occurring near Harper's Fer *Harpers Ferry folio* (Folio 10), 1894, pp. 3, 5).

[7] The term "Wellington shales," apparently appli an article by Professor Cragin, in the Kansas City *Revi* VIII, April, 1895, p. 679; and a little later he published *Laboratory of Natural History*, Vol. I, May (?), 188

SSIFICATION OF THE UPPER PALEOZOIC FORMATIONS OF KANSAS.

- Cragin, '96.
  - Kiger Stage [1] - Cragin, '96.
    - Taloga formation - - - - - - - - - - Cragin, '97.
    - Day Creek dolomite - - - - - - - - - Cragin, '96.
    - Red Bluff formation - - - - - - - - - Cragin, '96.
  - Salt Fork Stage - Cragin, '96.
    - Dog Creek formation, Cragin, '96.
      - Chapman dolomite,[5] Cragin, '97.
      - Amphitheatre dolomite, Cragin, '97.
    - Cave Creek formation, Cragin, '96.
      - Shimer gypsum - Cragin, '96.
      - Jenkins clay - Cragin, '96.
      - Medicine Lodge gypsum, Cragin, '96.
    - Glass Mountain formation, Cragin, '97.
      - Flower-pot shales - Cragin, '96.
      - Cedar Hills sandstone, Cragin, '96.
    - Kingfisher formation, Cragin, '97.
      - Salt Plain member - Cragin, '96.
      - Harper sandstone [6] - Cragin, '96.
- Cragin, '96.
  - Summer Stage - Cragin, '96.
    - Wellington shales [7] - - - - - - - - - Cragin, '96.
    - Marion formation - - - - - - - - - - Prosser, '95.
  - Chase Stage - - - Prosser, '95.
    - Winfield formation - - - - - - - - - Prosser, '97.
    - Doyle shales - - - - - - - - - Prosser and Beede.
    - Fort Riley limestone - - - - - - - - - Swallow, '66.
    - Florence flint - - - - - - - - - - - Prosser, '95.
    - Matfield shales - - - - - - - - - Prosser and Beede.
    - Wreford limestone - - - - - - - - - - Hay, '93.
- Keyes, '96.
  - Council Grove Stage.
    - Garrison formation, Prosser and Beede.
      - Neosho member - Prosser, '95.
      - Florena shales, Prosser and Beede.
    - Alma limestone - - - - - - - - - Prosser, '94.
  - Wabaunsee Stage - Prosser, '95.
    - Eskridge shales - - - - - - - - - Prosser and Beede.
    - Neva limestone - - - - - - - - - Prosser and Beede.
    - Elmdale formation - - - - - - - - - Prosser and Beede.
    - Americus limestone - - - - - - - - - Kirk, '96.
    - ——— formation - - - - - - - - -
    - Emporia limestone - - - - - - - - - Kirk, '96.
    - ——— shales - - - - - - - - - -
    - Burlingame limestone - - - - - - - - . Hall, '96.

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(*Am. Geol.* Vol. XXVIII, p. 302.) It will be seen that the Oklahoman series, as precisely defined above is identical with the Big Blue series proposed by Dr. Cragin in 1896, and therefore his name, which has priority, is adopted for this classification. In my revision the only change from Professor Cragin's classification of the Big Blue series is that the Neosho member at its base is put in the Missourian series. The Brazos series proposed by Prof. Hill in 1902 (*Twenty-first Ann. Rept. U. S. Geol. Surv.* Pt. VII, p. 100) for the Red Beds is apparently the same as the Cimarron series of Cragin.

4 "Missourian" was proposed as the name of a series by Dr. Keyes, in July, 1896 (*Am. Geol.*, Vol. XVIII, pp. 25-27). This was an outgrowth of the Missouri stage or formation which was proposed by him in 1893 (*Iowa Geol. Surv.*, Vol. I, pp. 85, 114; and *Mon. Rev. Iowa Weather Service*, Vol. IV, p. 3).

5 Nearly three years later Professor H. S. Williams gave the name "Chapman sandstone" to a formation occurring in northeastern Maine (*Am. Jour. Sci.*, 4th ser., March, 1900, Vol. IX, pp. 203, 205, which was more fully described in *Bull. U. S. Geol. Surv.*, No. 165, 1900, p. 78).

6 It is not probable that "Harper sandstone" can be retained for this subformation, because the very similar term of "Harper's shale" was published by Keith two years earlier as the name of a formation occurring near Harper's Ferry (*Geologic Atlas United States, Harpers Ferry folio* (Folio 10), 1894, pp. 3, 5).

7 The term "Wellington shales," apparently applied to this formation, first appeared in an article by Professor Cragin, in the Kansas City *Review of Science and Industry*, Vol. VIII, April, 1895, p. 679; and a little later he published it in the *Bull. Washburn College Laboratory of Natural History*, Vol. I, May (?), 1885, p. 86.

the Cincinnati series of the Ordovician in Minnesota, for which he proposed "a new name . . . . *Wykoff* beds — from the town near which the best exposure known occurs."[1] and this he later called the Wykoff formation.[2] The only difference is that the name of the Minnesota town is spelled without a *c*. In 1895 Professor Haworth proposed the name "Osage City shales" for the rocks included between the top of the Topeka limestone and the base of a thin limestone overlying the Osage coal; while about 150 feet of the superjacent rocks in the vicinity of Burlingame were named the Burlingame shales.[3] Later in the same year both divisions were more fully described by Professor Haworth;[4] but the upper limit of the Burlingame shale was not precisely defined. The following year Mr. Hall applied the term "Burlingame limestone" to eight feet of limestone which "covers the third and last heavy bed of shales in this section" with a thickness of 150 or 200 feet.[5]

This shale was apparently regarded by Mr. Hall as the Burlingame, since he used that name in the list of subjects at the beginning of his chapter,[6] and then the heading following that of the Burlingame limestone is the "Systems above the Burlingame shales."[7]

In 1898 Professor Haworth stated that "subsequent work has shown the unimportance of" the thin limestone overlying the Osage coal, "so that it will not do to depend upon it as a division line marker. Neither will the Osage coal serve such a purpose, as it is by no means continuous . . . . From these considerations it seems desirable to let the name Osage apply to the entire shale bed above the Topeka limestone and below the Burlingame limestone . . . This renders the name Burlingame shales superfluous and therefore it will be dropped."[8]

[1] *Bull. Minn. Acad. Nat. Sci.*, Vol. III, No. 3, 1891 (?), p. 326. It is stated by Professor N. H. Winchell and E. O. Ulrich that this paper was not distributed until April 9, 1892 (*Geol. Minn.*, Vol. III, Pt. I, of the final report, 1895, p. XLVI).

[2] *Am. Geol.*, Vol. XIX, Jan., 1897, p. 24; see also *ibid.*, May, 1897, pp. 332, 334.

[3] *Kan. Univ. Quart.*, Vol. III, April, 1895, p. 278.

[4] *Am. Jour. Sci.*, 3d ser., Vol. L, December, 1895, pp. 461, 462.

[5] *Univ. Geol. Surv. Kan.*, Vol. I, 1896, p. 105. [6] *Ibid.*, p. 99. [7] *Ibid.*, p. 105.

[8] *Ibid.*, Vol. III, p. 105; also see p. 73.

In 1898 Dr. Adams applied the name "Eureka limestone" to a formation exposed in the vicinity of that city,[1] which Professor Haworth correlated with the Burlingame limestone.[2] The name Eureka, however, was preoccupied, since Hague used it in 1883 for the Eureka quartzite of Nevada,[3] and later Dr. Branner named the Eureka shale of Arkansas.[4]

——— *shales.*— In Lyon county, succeeding the Burlingame limestone, according to Mr. Alva J. Smith, are nearly forty-five feet of blue to yellow shales and friable limestones, the latter comprising about eight feet of the total thickness of this formation, which is limited at the top by the Emporia blue limestone.[5] Dr. Adams has recognized as a formation the shales included between the Burlingame and Emporia limestones, which he has named in manuscript, and therefore no name is proposed for the division in this article.

Emporia limestone.— This division, as described by Mr. Smith, is composed of three feet of hard blue limestone at the base, the upper six-inch layer making a good flagstone, which is extensively used in Emporia. Then there is four feet of shale capped by another hard blue limestone two feet in thickness. These limestones "pass under the Cottonwood River at Soden's mill, one mile south of Emporia,"[6] and the Neosho River at the Rinker bridge. It was named by Kirk in 1896,[7] but, according to Mr. Smith, at some of the localities which he mentioned it was confused with a higher limestone. The blue Emporia limestone was correctly reported by Kirk in the "Chicago Mound" near Wyckoff; but the limestones near the "Emporia waterworks" and "along the hilltops about four miles south and one mile east of Emporia"[8] are higher and belong in what Mr. Smith named the "Emporia system."[9] The lower limestone

[1] *Ibid.*, p. 67. [2] *Ibid.*, p. 73. [3] *Third Ann. Rept. U. S. Geol. Surv.*, pp. 253, 262.

[4] *Ann. Rept. Geol. Surv. Ark.*, for 1888, Vol. IV, 1891, p. 13, and see description by Professor Simonds on p. 26.

[5] See *A Bulletin on Lyon County Geol.*, 1902, pp. 2, 10; and *Trans. Kan. Acad. Science*, Vol. XVII, 1901, p. 193.

[6] *Bull. Lyon County Geol.*, pp. 2, 10; and *Kan. Acad. Sci.*, Vol. XVII, p. 193.

[7] *Univ. Geol. Surv. Kan.*, Vol. I, p. 80. [8] *Ibid.*, p. 82.

[9] Letter of Mr. Smith, Jan. 20, 1902. For a description of the Emporia system see *Bull. Lyon County Geol.*, p. 3.

was called the "Emporia blue" by Mr. Smith,[1] who states that it is much more uniform than the upper, and that he has traced it across Lyon county. He also identified it two miles east of Harveyville, in Wabaunsee county, and four miles northwest of Eureka, in Greenwood county. It appears to be a persistent limestone for some considerable distance, which can be traced and mapped, and is, therefore, probably entitled to rank as a substage of the Wabaunsee.

——— *formation.*— Above the Emporia limestone, as described by Mr. Smith, is a zone nearly seventy feet thick, composed mainly of shale, but with a foot of limestone and a five-inch stratum of coal in the lower part, and a five-foot sandstone near the top. Then comes a zone composed of five limestone strata from one to two feet in thickness, separated by shales from four to ten feet thick, and with a total thickness of twenty-four feet. Mr. Smith named this zone the Emporia system,[2] and has represented its distribution three-fourths of the distance across Lyon county.[3] He writes me, however, that "the five limestones which I have included in the Emporia system are not very persistent, and the character and thickness of the stone, as well as the intervening shale, are subject to sudden changes. I have been unable to identify it beyond the lines of this county."[4] It hardly appears desirable to regard this zone as entitled to the rank of a formation. Then, according to the measurements of Mr. Smith, there are 210 feet of rocks composed largely of sandy shales, but also containing some thin beds of limestone, coal, and sandstone. The most important coal stratum is ten inches in thickness, and it occurs 75½ feet above the base of this member. So far as I am able to judge, it would appear advisable to put these three members in one formation, giving it a thickness of about three hundred feet. Dr. Adams ranked the rocks included between the Emporia and Americus limestones as a formation, which he has named in manuscript, and, therefore, no name is proposed for this formation.

[1] *Ibid.*, p. 2. [2] *Bull. Lyon County Geol.*, 1902, p. 3.

[3] *Trans. Kan. Acad. Sci.*, Vol. XVII, 1901, p. 191; and *Bull. Lyon County Geol.*, p. 8.

[4] Letter of January 20, 1902.

Americus limestone.— This name was given by Kirk in 1896 to two thin layers of limestone, separated by shale, which are quarried near Americus.[1] It was also noted by Haworth and Kirk in their "Neosho river section" and called "limestone system No. 11."[2] The lower stratum is buff in color, very solid and compact, making a good building stone with a thickness of twenty-one inches, according to Smith. Then comes six feet of shale with a six-inch flag limestone on top,[3] making a total thickness of over eight feet, and its distribution has been mapped entirely across Lyon county by Smith.[4] On the Cottonwood Falls quadrangle it is probable that this limestone is only a few feet below water in the Cottonwood River east of Elmdale.

Elmdale formation.— This formation, the succeeding ten and the lower and middle parts of the Marion, are represented on the Cottonwood Falls quadrangle, which has also furnished the majority of the names, and consequently these have been more thoroughly studied by the writer than the preceding formations. It is about 130 feet in thickness, and composed of yellowish to bluish shales, with thin beds of grayish alternating limestone, including two or three thicker ones. About thirty feet above the base of the formation is a friable limestone with a thickness in some localities of four feet, which is composed to a large extent of the tests of *Fusulina secalica* Say. This stratum weathers readily and leaves great numbers of *Fusulina* in the soil. About thirty-five feet higher is another conspicuous yellowish limestone, the center of which weathers to a rough face, and from ten to fifteen feet below the top is a limestone stratum from three to five feet in thickness. The formation is limited at the base by the top of the Americus limestone, and at its top by the base of the massive Neva limestone. It is well exposed on the bluff east of Elmdale, from which town it is named.

[1] *Univ. Geol. Surv. Kan.*, Vol. I, pp. 80, 81.

[2] *Kan. Univ. Quart.*, Vol. II, January, 1894, p. 111.

[3] *Bull. Lyon County Geol.*, pp. 3, 10.

[4] *Trans. Kan. Acad. Sci.*, Vol. XVII, 1891, p. 191; and *Bull. Lyon County Geol.*, p. 8.

Neva limestone.— This formation consists of a massive bluish-gray limestone or of a lower and upper massive limestone, each one a little over four feet in thickness, separated by two feet of shales, with a total thickness of about ten feet. The limestone, forming frequent ledges seven feet or more in thickness, breaks off in large blocks with sharp angles and a rough, jagged surface, weathering to a color not dissimilar to that of bleached bones. It was noted by Swallow in 1866[1] and represents the upper stratum of Haworth and Kirk's "limestone system No. 12,"[2] to which "system" Kirk later apparently applied the name "Dunlap limestone."[3] The limestone is finely exposed in the anticlinal fold to the northeast of Neva, a station on the Atchison, Topeka & Santa Fe railroad near the junction of the Diamond Creek and Cottonwood River valleys, hence its name.

Eskridge shales.— Between the Neva and the next higher massive limestone is a mass of shales, with perhaps some thin limestone layers, varying from thirty to forty feet in thickness. The shales are of greenish, chocolate, and yellowish color, and usually form covered slopes between the two conspicuous limiting limestones. They form the upper division of the Wabaunsee stage, and are named from the exposures in the vicinity of Eskridge, Wabaunsee county.

COUNCIL GROVE STAGE.

In my original description of these formations the line of separation between the Upper Coal-measures and Permian was doubtfully drawn between the Cottonwood and Neosho formations;[4] while the Permian appeared as a series of the Carboniferous, in accordance with the usage of the United States Geological Survey.[5] Since then Dr. Frech has reviewed this classification and drawn the lower line of the lower Dyas (Permian) at the base of the Chase stage, while it is stated that the Neosho is a transition to the Carboniferous, and a distinct line fails.[6]

[1] *Prelim. Rept. Geol. Surv. Kan.*, p. 16, Nos. 82–4.

[2] *Kan. Univ. Quart.*, Vol. II, 1894, p. 112.

[3] *Univ. Geol. Surv. Kan.*, Vol. I, 1896, p. 81.

[4] JOUR. GEOL., Vol. III, 1895, p. 800.

[5] See *Ibid.*, p. 796, f. n.

[6] *Lethaea palaeozoica*, Bd. II, 2 Lief., 1899, p. 378.

On the chart showing the partial distribution of the Carboniferous, the Chase is apparently given as corresponding to the lower part of the Arta stage, which, according to his classification, is the oldest stage of the Permian, and the Neosho is represented as about on the dividing line between the Permian and Upper Carboniferous, although perhaps it is intended to include all of it in the latter division.[1] It is stated, however, that the older Chase and Neosho strata (as compared with the Marion) beyond doubt can only correspond to the Artinsk stage (which is the oldest Permian of Russia=Arta stage), and that a sharper division is made impossible by the absence of Cephalopods.[2] It is to be noted that in the latter part of this work devoted to "Die Dyas," in the table of Kansas Dyassic formations, Dr. Frech has left the Neosho as the oldest division of the Palæo-Dyas. In this case, however, he was reporting the classification of Professor Cragin, for it is stated that in the following table the Kansas strata are enumerated according to a recent survey, and it is not thought that he intended to set aside his earlier correlation.[3]

In reference to the correlation of these divisions the writer has stated that "The appearance and the prominence of the *Pseudomonotis* fauna in the Neosho formation furnishes a strong reason on the biologic side" for its correlation with the Permian.[4] The presence of *Pseudomonotis* is no longer an important argument in favor of putting the Neosho in the Permian, because since then Dr. Beede has identified *Pseudomonotis Hawni*, and described a new variety of that species and two new species from the older formations of the Upper Coal-measures of Kansas.[5]

There is a marked lithologic change at the base of the Chase stage where it begins with the Wreford limestone, which is the lowest one of the very cherty massive limestones. It is perhaps

[1] *Ibid.*, "Tab. XXIV, Einige wichtige Vorkommen des Carbon."

[2] *Ibid.*, p. 377, f. n.: "Dass die tieferen Chase-und Neosho-Schichten nur der Artinskischen Stufe entsprechen können, steht ausser Zweifel; jedoch wird eine schärfere Abgrenzung durch das Fehlen der Cephalopoden unmöglich gemacht."

[3] *Ibid.*, 3 Lief., 1901, p. 514.

[4] JOUR. GEOL., Vol. III, 1895, p. 796.

[5] *Kan. Univ. Quart.*, Vol. VIII, April, 1899, Ser. A., pp. 79–84; and *Univ. Geol. Surv.*, Vol. VI, 1900, pp. 132–35.

a more satisfactory classification to regard the base of the Permian as marked by the lower limit of the Wreford limestone and the writer is inclined to accept this line for the division as indicated by Dr. Frech. If this be done the writer would class the two formations succeeding the Eskridge shales (Cottonwood limestone and Garrison) together to form a stage for which he would propose the name of Council Grove. The upper part of the stage is well shown in the bluffs of the Neosho River and its tributaries in the immediate vicinity of this city, while the Cottonwood limestone and the overlying Florena shales may be found in the Neosho valley, about six miles below Council Grove.

Alma limestone.—This is a massive light gray to buff-colored, foraminiferal limestone, frequently composed of two layers with a thickness of about six feet. It contains very few fossils, with the exception of *Fusulina secalica* Say, which is extremely abundant in its upper part, and is called "wild rice" by the quarrymen. It is the most important dimension stone in Kansas, and at various localities are extensive quarries. Its constant lithologic character, with its line of outcrop frequently marked by a row of massive light gray rectangular blocks filled with *Fusulina*, make it one of the most important stratigraphic horizons in the Upper Paleozoic rocks for at least two-thirds of the distance across Kansas and into Nebraska. Swallow called the stratum the Fusulina limestone,[1] and for years it has been known commercially as the Cottonwood or Cottonwood Falls limestone, and at other localities as the Alma and Manhattan limestone. Haworth and Kirk, in their "Neosho River section," called it "limestone system No. 13, which is considered the equivalent of the famous Cottonwood Falls limestone;"[2] but in their description of the quarries near Cottonwood Falls, under their "Cottonwood River section," simply called it "No. 13,"[3] and did not apply to it the term Cottonwood Falls limestone. The same year Prosser proposed the name "Cottonwood formation" for the limestone and superjacent fossiliferous

[1] *Prelim. Rept. Geol. Surv. Kan.*, 1866, p. 16.

[2] *Kan. Univ. Quart.*, Vol. II, Jan. 1894, p. 112. [3] *Ibia.*, p. 113.

shales, on account of the excellent outcrops of both in the bluffs bordering the Cottonwood River below and above Cottonwood Falls and Strong. The lower division was named the "Cottonwood limestone" and the upper the "Cottonwood shales,"[1] while the same limestone quarried in the vicinity of Alma was mentioned locally as the "Alma massive limestone."[2] The following year the formation and its two members were more fully described by Prosser.[3] The name "Cottonwood," however, was apparently used for a geological division by N. F. Drake as early as September, 1893, when he described the "Cottonwood Creek bed" of the Texas Carboniferous.[4] It is now proposed to limit the formation to the Cottonwood limestone and on account of the prior use of the name Cottonwood for the Texan bed, to call it the Alma limestone from the outcrops near the town of that name in Wabaunsee county, while the Cottonwood shales are referred to the succeeding formation.

Garrison formation.—This formation is composed of two members, the yellowish fossiliferous shales at the base, formerly called the Cottonwood shales, and the upper one, composed of the alternating gray limestones and various colored shales called the Neosho, with a total thickness of from 140 to 145 feet. The lower shales have a thickness of thirteen feet near Strong, but decrease to two or three feet in the northern part of the state. The lower part of these shales contains immense numbers of a few species of fossils and on this account may be readily identified wherever outcrops occur. Since the geographic name "Cottonwood" is preoccupied the term "Cottonwood shale" is abandoned, and they are renamed the Florena shales from the exposures over the Alma limestone in the quarries near Floren, in the Big Blue valley.

The upper member of the formation is composed of green, chocolate, and yellowish shales alternating with grayish limestones, while in the Big Blue valley a bed of gypsum occurs near the base. Certain layers of the coarser shales and limestones

[1] *Bull. Geol. Soc. Amer.*, Vol. VI, Nov. 1894, p. 40.

[2] *Ibid.*, p. 44.

[3] JOUR. GEOL., Vol. III, Oct. 1895, pp. 697–705.

[4] *Fourth Ann. Rept. Geol. Surv. Texas*, pp. 374, 382.

contain an abundant Lamellibranch fauna, and the entire fauna is thought to be a mixture of species found in the western Coal-measures, together with others occurring in the division generally termed the Permian or the Permo-Carboniferous. This member was originally termed the Neosho formation from the excellent outcrops in the Neosho valley near Council Grove.[1] The Florena shales and Neosho member are now united to form the Garrison formation, so named on account of the good exposures from Garrison south in the Big Blue valley.

CHASE STAGE.

As in the case of the Wabaunsee, it has been found advisable for mapping to divide this stage, which was formerly called the Chase formation, into several formations, which are described in ascending order. These subdivisions of the Wabaunsee and Chase stages are sufficiently definite lithologic divisions to be traced across the Cottonwood Falls quadrangle, and some distance to the north and south, and therefore can be mapped. It does not appear to the writer, however, that these divisions are entitled to the rank of a stage, and he would term them substages. If we consider the well-known Hamilton division a stage of the New York Devonian, then it would appear that these divisions correspond more nearly to the Moscow shales, Encrinal limestone, Ludlowville shales, and other subdivisions of that stage, than to the entire Hamilton.

Wreford limestone.—This formation is composed of limestone and chert, or flint as it is popularly termed throughout the Flint Hills region, and varies in thickness from thirty-five to fifty feet. In general it is composed of three strata, a cherty limestone below and above, separated by a heavy limestone nearly free from chert. The rock is buff in color, often weathering much lighter, and forms the first conspicuous flint terrace above the Alma limestone. It is quite extensively quarried and used for construction stone or crushed for railroad ballast. It was called the Strong flint in 1895,[2] but is now known to be the equivalent of the Wreford limestone, which was named by

[1] JOUR. GEOL., Vol. III, 1895, p. 764. [2] JOUR. GEOL., Vol. III, p. 773.

Professor Hay in 1893 from exposures near Wreford, Geary county, south of Junction.[1] The preceding report of the State Board contained the same table of Professor Hay's "Fort Riley section," except that this division was called the "Walford limestone," which was undoubtedly a typographical error for Wreford.[2]

Matfield shales.—The formation is composed principally of variously colored shales, with some shaly buff, occasionally cherty limestones, and a light gray limestone two feet or so in thickness, which occurs about thirty feet below its top. The thickness ranges from sixty to seventy feet, and it generally forms covered slopes between two massive and conspicuous flint ledges. It is named from Matfield township, Chase county, where it forms the side of the steep escarpment above the Wreford limestone.

Florence flint.—This formation is about twenty feet in thickness and consists of very cherty limestone separated by definite layers of chert, with a band of shaly or white cellular limestone near the center. It is excellently exposed on the McPherson branch of the Atchison, Topeka & Santa Fé Railroad, and in the Jones quarries along that railroad, from one to two miles northeast of Florence, and on this account in 1895 it was named the "Florence flint."[3]

Fort Riley limestone.—Overlying the Florence flint is a series of massive buff limestones, changing to thin bedded and shaly strata in the upper part of the formation, which have a total thickness of forty feet or more. Near the center of the formation are generally one or two massive layers, which on the weathered surface form a conspicuous ledge that may be readily followed by the eye for miles on the bluffs of the Cottonwood and Kansas rivers. Swallow in 1866 applied the term "Fort Riley limestone" to the massive ledge in the vicinity of Fort Riley, which he described as "a buff porous magnesian rock, in thick beds," with a thickness of from eight to ten feet.[4] This

[1] *Eighth Bien. Rept. Kan. State Board Agri.*, Part II, p. 104.

[2] *Seventh ibid.*, 1891, Part II, p. 94.

[3] JOUR. GEOL., Vol. III, p. 773.

[4] *Prel. Rept. Geol. Surv. Kansas*, p. 14.

name is now adopted for this formation, but its limits are extended to include the thinner bedded limestones both below and above the massive Fort Riley main ledge. The Florence limestone[1] is apparently equivalent to the Fort Riley main ledge and the name is now abandoned.

Doyle shales.—This formation is composed of variously colored shales with an occasional thin stratum of soft limestone, and has a thickness of sixty feet. About twenty feet above the base is a thin, grayish limestone which often appears on the surface, and at the top are yellowish shales containing a few fossils. These shales and the rocks of the overlying formations weather easily and form gently undulating prairies in sharp contrast with the rough topography produced by the flint and massive limestones below. The formation is shown at various places in the Doyle Creek valley to the southwest of Florence, from which locality it is named the Doyle shales.

Winfield formation.—This has a thickness of about twenty-five feet, and is composed of a cherty limestone at the base with a massive concretionary one at the top, the two separated by yellowish shales. This chert and concretionary limestone form the highest prominent chert ledge in the Kansas Permian, and make a marked stratigraphic horizon that is of great assistance in determining the areal geology of eastern central Kansas. The chert is not so uniform in occurrence as in the Wreford and Florence flints, and at some localities this horizon is represented simply by a prominent light gray limestone, nearly free from chert. The concretions in the upper limestone are quite persistent through long stretches of outcrop, although occasionally areas are found where they are small and inconspicuous or absent. As a rule, however, they are large, and the stratum may readily be traced across the country either from its exposure in bluffs or streams or from the line of loose reddish-brown concretions stretching across the prairie. The irregular worn upper surface of the concretionary limestone and the appearance of many of the concretions, as though rolled in the mud on the sea bottom, indicate a shallowing of the sea at this time, fol-

[1] JOUR. GEOL., Vol. III, 1895, p. 773, No. 15 of the Chase section.

owed by a subsidence of the sea bottom before the deposition of the succeeding even thin bedded limestones. This change of physical condition is indicated in the fauna by the nearly complete disappearance of the brachiopods and the survival of a fauna composed mainly of Permian lamellibranchs. This formation constitutes the upper division of the Chase stage, and in the preliminary description of these rocks it was called the "Marion flint and concretionary limestone"[1] from the outcrops below Marion, and regarded as a subformation. The overlying buff limestone and shales, however, were named the Marion formation and hence to avoid confusion the name Marion was dropped for the lower division and it was renamed the Winfield concretionary limestone from the outcrops in the vicinity of Winfield, Cowley county, in southern Kansas.[2] Fourteen months later Dr. Keyes published the name "Winfield limestone," which he applied to a Cambrian formation found in the Mississippi valley near Winfield, Lincoln county, Missouri.[3] In 1900 Professor Harris and Mr. Veatch applied the very similar name of Winnfield limestone (spelled Winn) to a Cretaceous formation of northern Louisiana.[4] Clearly the Kansas usage of the name has priority, and Winfield is adopted as the name of this formation.

SUMNER STAGE.

The two upper formations of the Big Blue series (the Marion and Wellington shales) were classed together by Professor Cragin to form the Sumner division.[5] It was named after Sumner county in southern Kansas which includes nearly the entire breadth of its outcrop in that part of the state. This name is retained for this division, which is considered to have the rank of a stage.

Marion formation.—Buff thin-bedded limestones and shales form the principal part of this formation which is the latest Paleozoic one found on the Cottonwood Falls quadrangle. The

[1] JOUR. GEOL., Vol. III, 1895, p. 772.

[2] *Univ. Geol. Surv. Kan.*, Vol. II, Feb. 15, 1897, p. 64.

[3] *Proc. Iowa Acad. Sci.*, Vol. V, April 28, 1898, p. 60.

[4] *Geol. Surv. La.*, Report for 1899, Sec. II, p. 56.

[5] *Col. Coll. Studies*, Vol. VI, pp. 3, 9, 48.

lower part is composed of rather soft, porous, thin-bedded limestones and shaly layers to shales, containing near the base a considerable number of silicious geodes and occasionally some chert. Some fifty or sixty feet above the base is a buff limestone containing large numbers of small lamellibranchs, as *Pleurophorus subcuneatus* M. & H., *Bakewellia parva* M. & H., *Yoldia subscitula* M. & H., and other species, while about twenty feet higher is another similar limestone containing large lamellibranchs, as *Aviculopecten occidentalis* (Shum) Meek, *Myalina permiana* (Swallow) M. & H., and *Pseudomonotis Hawni* (M. & H.). A limestone containing *Pleurophorus* occurs in some localities near this horizon, which also contains large chert concretions.

The upper portion of the formation is composed mostly of thin buff limestones similar to those in the lower portion, alternating with a greater thickness of shales and marls, and in some localities contains beds of gypsum and salt. On Turkey Creek, south of the Smoky Hill valley and Abilene, a conglomerate stratum from fifteen to twenty feet in thickness occurs some 150 feet above the base of the formation, which was first described by Meek and Hayden in 1859.[1] To the northwest of the Cottonwood Falls quadrangle two beds of gypsum occur in this formation in Dickinson and Saline counties, both of which are worked. The lower one was named the "Solomon gypsum" by Dr. Grimsley,[2] and various outcrops occur up Gypsum Creek to Gypsum, as well as on Holland Creek, near Dillon. The higher bed is found in Greeley township, southeast of Salina, which was called the "Greeley gypsum" by Dr. Cragin,[3] while at Hope in the southeastern part of Dickinson county both strata of gypsum occur, separated by one hundred feet of shales and limestones. In southern central Kansas there are indications of a third horizon, forty feet above the Greeley gypsum, while the deposit in the southern part of the state, about four miles northwest of Geuda Springs, Sumner county, is in the upper part of the forma-

[1] *Proc. Acad. Nat. Sci. Philadelphia*, Vol. IX, p. 16, No. 9.

[2] *Univ. Geol. Surv. Kan.*, Vol. V, 1899, p. 61.

[3] *Col. Coll. Studies*, Vol. VI, 1896, p. 10.

tion.[1] In the southern part of the state the upper portion of the formation consists to a large extent of clay-shales of various colors, with some beds of limestone, gypsum, and rock salt. Its lithologic character, as it dips deeply below the surface to the westward, is shown by the well records to change from the variegated shales alternating with beds of limestone and gypsum to saliferous shales of bluish-gray to slate color alternating with massive beds of rock salt. It covers a large portion of the eastern two-thirds of Marion county, its lower part is quite well shown in the vicinity of the city of Marion, and for these reasons it was given the name "Marion formation."[2] On account of the terms "Marion flint" and "Marion concretionary limestone," Professor Cragin, in 1896, named this formation the "Geuda Salt-measures," from Geuda, Sumner county,[3] which name he withdrew during that year in favor of the "Marion formation."[4]

Wellington shales.—This formation consists largely of bluish-gray to slate-colored shales, but contains some red ones, and in the southern part of the state beds of impure limestone and calcareous shales, together with occasional beds of gypsum and dolomite. Limited saline deposits are reported, but no rock salt. Fossils are very rare, and, as far as the writer is informed, none have been found in the formation. In the Smoky Hill valley there are about two hundred feet of the Wellington shales, but they thicken to the south, and are reported as 450 feet in thickness in Sumner county, near the southern line of the state. Professor Cragin named and described these shales in 1896 from exposures in the vicinity of Wellington, the county seat of Sumner county.[5]

TABLE OF THE UPPER PALEOZOIC FORMATIONS OF KANSAS.

The formations just described, together with the succeeding ones of the Permian, have been arranged in the following table of the Upper Paleozoic formations of Kansas.

[1] See DR. GRIMSLEY'S account in *Univ. Geol. Surv. Kan.*, Vol. V, 1899, p. 69.

[2] JOUR. GEOL., Vol. III, 1895, p. 786.

[3] *Col. Coll. Studies*, Vol. VI, March, 1896, pp. 3, 9–16.

[4] *Am. Geol.*, Vol. XVIII, Aug., 1896, p. 132.

[5] *Col. Coll. Studies*, Vol. VI, pp. 3, 16.

CORRELATION OF THE CIMARRON SERIES.

In the earlier papers of the writer, the Cimarron series was referred provisionally to the Permian[1]; but later the discovery of Permian fossils as high as the Red Bluff formation, together with other data, apparently proves that at least the greater part of the series is of Permian age. Most of the fossils have been found by Professors A. H. Van Vleet and Charles N. Gould; the latter has described the horizons from which they were collected and given a list of three specific and three generic identifications of Permian vertebrates by Dr. Williston, which came from near the base of the Harper sandstone, and eleven genera of invertebrates identified by Dr. J. W. Beede. He states that the highest locality, which is in the Red Bluff formation, "has yielded some twenty species of invertebrates, several of which are of new forms."[2]

Dr. Beede, who has also published a note concerning these highest fossils, states that "they are mainly pelecypods with a species of brachiopod and a few gasteropods. . . . *Aviculopecten occidentalis* (Shum) Meek, is also present, and one other species bearing somewhat of a resemblance to it, but quite different from it in some respects, is also present. One of the common fossils is a biplicate terebratuloid, *Dielasma Schucherti* Beede, belonging to a group of this genus heretofore unknown in the American Permian. Mr. Schuchert informs me that it is very similar to a species of this genus described by Waagen from the Permian of Europe. . . . .

The presence of these fossils clearly demonstrates the Permian age of these rocks, coming as they do from very near to the top of the beds."[3] The description of these invertebrate fossils from the Red Beds by Dr. Beede has been published as an Advance Bulletin of the First Biennial Report of the Oklahoma Geological Survey.[4] The following new species are

[1] *Univ. Geol. Surv. Kansas*, Vol. II, 1897, pp. 89–92; *Kan. Univ. Quart.*, Vol. VI, 1897, pp. 150, 151; JOUR. GEOL., Vol. VII, 1899, pp. 354–6.

[2] JOUR. GEOL., Vol. IX, July, 1901, p. 339.

[3] *Am. Geol.*, Vol. XXVIII, July, 1901, pp. 46, 47.

[4] April, 1902, pp. 1–11, with one plate.

described: *Bakewellia Gouldii*, *Conocardium oklahomaensis*, *Aviculopecten Van Vleeti* and *Dielasma Schucherti*; *Aviculopecten occidentalis* is identified and, generically, specimens of *Naticopsis*, *Pleurotomaria*, *Schizodus*, *Lima* and *Pleurophorus*, all of which are from White Horse Springs, Oklahoma. Dr. G. I. Adams also states that Dr. Williston considers the vertebrate remains from the Harper sandstone "as equivalent to Cope's Lower Permian fauna from the Wichita beds of Cummins in northern Texas."[1] He further said, in discussing the age of the Red Beds of eastern Oklahoma, that "The age of that portion of the Red Beds which is in strike with the Permian of Kansas may confidently be expected to be found to be of Permian age. This is in accordance with the evidence already furnished by the vertebrate fossils. Above the Permian limestones in Kansas occur the Wellington shales, which are bluish and greenish-gray in color. They are probably represented southwestward by formations which are red. The succeeding formations are typical Red Beds, and have thus far yielded only Permian fossils."[2]

In a discussion of the "Relations of 'Upper Permian' to Triassic" Dr. Keyes has stated that "Prosser has been led to believe that the greater part of the Kansas 'Red Beds' are Triassic."[3] The above statement is erroneous, for previous to the publication of Dr. Keyes' paper my discussion of the Cimarron series in the Kansas report appeared under the heading of "The Upper Permian." At that time, however, I did not consider the evidence strong enough to justify their correlation with the Permian without a question.[4] This idea was expressed near the close of the section on "Correlation" in the following sentence: "On account of this dissimilarity in lithologic characters [between the Red Beds of Texas and Kansas] and the absence of fossils in Kansas and northern Oklahoma, together with the fact that there is yet no account of the careful tracing of any part of the Red-Beds across Oklahoma to Texas where their age

[1] *Am. Jour. Sci.*, 4th ser., Vol. XII, Nov., 1901, p. 383.

[2] *Ibid.*, p. 386. [3] JOUR. GEOL., Vol. VII, July, 1899, p. 339.

[4] See the table of classification in *Univ. Geol. Surv. Kansas*, Vol. II, Feb., 1897, p. 94.

could be determined by comparison with the fossiliferous terranes, the correlation of these rocks with either the Triassic or Permian is a matter of uncertainty."[1] In the later paper of that year I simply quoted the opinions of Dr. Williston, Professor Grimsley and Mr. Vaughan, without expressing any opinion, beyond the statement that "there is uncertainty as to their age,"[2] while in my paper succeeding that of Dr. Keyes' in the same number of the JOURNAL OF GEOLOGY it was stated that "The Paleozoic of Kansas closes with the Cimarron group or the Red Beds;"[3] following which was an account of the identification by Dr. Williston of *Eryops megacephalus* from the lower part of the Cimarron series, an amphibian described by Cope in the Permian of Texas.

THE PERMIAN QUESTION.

CORRELATION OF THE UPPER PALEOZOIC OF KANSAS WITH THE RUSSIAN PERMIAN.

Opinions of various geologists.—There is still a difference of opinion among American geologists in regard to the correlation of the Upper Paleozoic formations of Kansas with the Russian Permian. The JOURNAL OF GEOLOGY published in 1898, "A symposium on the classification and nomenclature of geologic time-divisions," in which Dr. Williston,[4] Professor Calvin[5] and Dr. Keyes[6] reported adversely both as to the identification of the Permian in Kansas and to its recognition as a period coördinate with the Carboniferous or Devonian; while Dr. William B. Clark stated that for the later divisions of the Paleozoic he should employ the chronologic terms Carboniferous and Permian.[7] Dr. Clark wrote me later as follows regarding this subject:

> I distinctly object to the abandonment of the term Permian for a major division and can see no just grounds for it since the division is one of importance in Europe and other portions of the world. To be sure, in America the Permian conditions are not as prominent, but I can see no reason on that ground for disturbing the geological column as it has come to be generally accepted.[8]

[1] *Ibid.*, p. 92. [2] *Kan. Univ. Quart.*, Vol. VI, Dec. (?), 1897, p. 150.
[3] *Loc. cit.*, Vol. VII, p. 354. [5] *Loc. cit.*, p. 353. [7] *Loc. cit.*, p. 341.
[4] *Loc. cit.*, Vol. VI, p. 343. [6] *Loc. cit.*, p. 352. [8] Letter of December 16, 1898.

Vertebrate fossils found in northern Texas led Professor E. D. Cope to the conclusion that the rocks were of Permian age and he stated that "The evidence now adduced is sufficient to assign the formation, as represented in Illinois and Texas, to the Permian."[1] The invertebrate fossils from the same beds were regarded by Dr. Charles A. White as indicating their Permian age.[2] The stratigraphy of the Upper Paleozoic formations of Texas was fully described by Professor W. F. Cummins, who referred them to the Permian.[3]

In recent years the following geologists have studied the Upper Paleozoic rocks of Oklahoma, Kansas or Nebraska and termed them Permian. Dr. James P. Smith who stated that "The lower Permo-Carboniferous strata of Kansas and Nebraska are probably also to be correlated with the Artinsk stage [basal Permian of Russia]."[4] Professor Cragin, who gave an extended account of "the Permian system in Kansas;"[5] Professor Wilbur C. Knight who wrote a similar paper on "The Nebraska Permian"[6] and showed from tables of distribution that "Of the forty-four genera of invertebrates known in the Kansas and Nebraska rocks, over three-fourths of them belong to the Permian of the Orient. The remainder are nearly all American genera and are chiefly pelecypods."[7] Prof. Knight has also stated that "From our present knowledge it seems advisable to refer the Red Beds of the Laramie Plains [Wyoming] to the Permian."[8] Dr. J. W. Beede, in his paper on "A Reconnaissance in the Blue Valley Permian"[9] described the Lower Permian as represented in Kansas north of the Kansas river and in southern Nebraska. And finally Professor Charles N. Gould and Doctor

[1] *Geol. Surv. Texas, Second Ann. Rept.*, 1891, p. 414.

[2] *Bull. U. S. Geol. Surv.*, No. 77, 1891.

[3] *Geol. Surv. Texas, Fourth Ann. Rept.*, 1893, p. 212.

[4] JOUR. GEOL., Vol, II, 1894, p. 194; and see pp. 188, 204. Also see *Proc. Am. Phil. Soc.*, Vol. XXXV, 1896, reprint pp. 11, 12, 24.

[5] *Col. Coll. Studies*, Vol. VI, 1896, pp. 1–49 and supplemented by one in the *Am. Geol.*, Vol. XIX, 1897, pp. 351–64.

[6] JOUR. GEOL., Vol. VII, 1899, pp. 357–75.

[7] *Ibid.*, p. 370. [8] JOUR. GEOL., Vol. X, 1902, p. 421.

[9] *Kan. Univ. Quart.*, Vol. IX, July, 1900 (1901), pp. 191–203.

Beede have shown from fossils, the Permian age of the Kansas-Oklahoma Red Beds.[1]

Another paleontologist, who is studying the fossils of the western Carboniferous writes me:

I don't believe that there is any Permian there at all, unless possibly the Marion and superjacent beds are Permian. I express the opinion with that qualification, (the possibility of the Marion being Permian), and another that the Kansas area *may* have been a shut-in basin and have retained its Carboniferous facies into Permian time.

Dr. Erasmas Haworth wrote me as follows:

I do not hesitate to say that I am most strongly opposed to the substitution of the term Oklahoman or any other for that of Permian. It looks now as though the whole of the Red Beds would be called Permian. Should this be done we will have a terrane which, along the southern line of Kansas, will be from 2,000 to 3,000 feet thick, or in other words as thick as the whole of the Coal-measures. This mass of earth is as different in all physical aspects from the Coal-measures as they are from any other terrane. It should be given a prominent place, but just how prominent I am not yet ready to express an opinion. I do not see how anybody can well settle the question of rank of the American Permian until all these questions are worked out, which work will necessitate an intimate examination of the territory lying between Kansas and Texas. I favor insisting on the use of the term Permian and let its rank stand as others have given it until somebody is ready to tell us in detail and in a connected way what we have in Kansas, Indian Territory, and Texas. As far as I can see the indications now are that the Permian ultimately, with the Red Beds included, shall be entirely separated from the Carboniferous.[2]

In 1891 Dr. Th. Tschernyschew, the former able director of the Russian Geological Survey and the authority on the middle and upper Paleozoic of Russia, in company with Professor H. S. Williams, examined the rocks as exposed along the Kansas river from Manhattan to Fort Riley. Their conclusions were reported as follows by Mr. Robert Hay: "While agreeing that the lower beds [at Fort Riley] are Permo-Carboniferous, they state that the upper beds — where the Phacoceras is — are decidedly Permian, the Russian professor assuring me that both

[1] GOULD, JOUR. GEOL., Vol. IX, 1901, pp. 337–41; BEEDE, *Am. Geol.*, Vol. XXVIII, 1901, pp. 46, 47; and *Adv. Bull. First Bien. Rept. Okla. Geol. Surv.*, 1902, pp. 1–11.

[2] Letter of December 16, 1898.

faunal and lithologic characters can be duplicated in the Permian of his own country."[1] The specimens of *Phacoceras* and other Cephalopods from Fort Riley and Junction, Kansas, were identified and described by Professor Alpheus Hyatt and came from the Fort Riley limestone. Therefore, according to the above statement Dr. Tschernyschew correlated the Fort Riley limestone and superjacent Paleozoic formations with the Permian of Russia.

Correlation of the Kansas and Texas beds.— Professor Cummins reported that:

> The *Phacoceras Dumblei*, Hyatt, has been found only along a very narrow horizon in the Texas Permian. . . . . This fact will assist materially in correlating the Texas and Kansas beds, as that fossil has been reported only from cne locality in the Kansas area, where it is associated with the same fossils as in Texas. It is quite certain that the Fort Riley horizon is the same as the Wichita division of Texas, and is at the very top of the division.[2]

In ascending order the divisions of the Texas Permian as described by Professor Cummins are the Wichita, Clear Fork and Double Mountain;[3] while the Albany division[4] was left "as the top of the Coal-measures"[5] although the statement was made that "It may be that the Wichita and Albany divisions are but different facies of the same formation" for the Wichita division north of the Brazos river "occupies the same position, stratigraphically, as the Albany beds on the south."[6] Later Professor Cummins proved the correctness of the latter supposition and stated that he "found the fact well established that the Wichita and the Albany divisions were the same in time of deposition, and therefore the Albany must be abandoned both as to its name and the age to which I had previously referred it, and

[1] *Trans. Kan. Acad. Sci.*, Vo XIII, 1893, p. 38.

[2] *Trans. Texas Acad. Sci.*, Vol. II, 1897, pp. 97, 98. Also see D. W. JOHNSON, in *Bull. Sci. Lab. Denison Univ.*, Vol. XI, 1900, p. 223.

[3] *Geol. Surv. Texas, Second Ann. Rept.*, 1891, pp. 361, 373. *Fourth ibid.*, 1893, pp. 224–32.

[4] Prof. Hill has shown that the Albany division of Cummins is the same as the one named and described at an earlier date by Prof. Tarr as the Coleman. *Twenty-first Ann. Rept. U. S. Geol. Surv.*, Pt. VII, 1902, pp. 96, 97).

[5] *Ibid.*, p. 224. [6] *Ibid.*, p. 223.

the beds composing the division must be referred to the Wichita division of the Permian. Since the Wichita division is now made to include the area heretofore referred to as the Albany division, it becomes at once the most important and interesting part of the Permian in North America."[1] And he concluded with the statement that "it has been determined that the Albany division, with its numerous fossils, is but another facies of the Wichita division which is beyond question Permian."[2]

If Professor Cummins be correct in correlating the Fort Riley limestone with the top of the Wichita division of Texas it very decidedly supports the reference of the Upper Paleozoic formations of Kansas to the Permian. He had stated that all the typical localities of invertebrate fossils described by Dr. C. A. White were included in the Wichita division, "the greatest number of vertebrate fossils described by Professor Cope" and the fossil flora described by Dr. I. C. White;[3] while the *Phaceras Dumblei* "was taken from the very top of the Albany division."[4]

The fossil named and described by Professor Heilprin as *Ammonites Parkeri* which was reported from rocks of Carboniferous age in Wise county, northern Texas,[5] was referred to *Popanoceras* by Professor James P. Smith[6] who stated, on the authority of Professor Cummins, that the *Popanoceras Parkeri* beds are in the Strawn [Richland] division and therefore of the age of the Lower Coal-measures.[7] The occurrence of this type in the Texas beds, however, led Karpinsky in 1889 to write as follows: Since the Popanoceratidæ up to the present time have not been found in other countries in deposits which are older than the Permo-Carboniferous (in which the commonest Ammonites occur),

[1] *Trans. Texas Acad. Sci.*, Vol. II, 1897, p. 97. Also see JAMES P. SMITH, *Proc. Am. Phil. Soc.*, reprint, 1896, p. 13.

[2] *Trans. Texas Acad. Sci.*, Vol. II, 1897, p. 97.

[3] *Geol. Surv. Texas, Fourth Ann. Rept.*, p. 225. Also see *Trans. Tex. Acad. Sci.*, Vol. II, 1897, pp. 94, 95.

[4] *Geol. Surv. Texas, Fourth Ann. Rept.*, p. 223.

[5] *Proc. Acad. Nat. Sci. Philadelphia*, 1884, Vol. 36, pp. 53–5.

[6] JOUR. GEOL., Vol. II, 1894, p. 194; and see "Correlation Table" on p. 204.

[7] *Proc. Am. Phil. Soc.*, Vol. XXXV, 1896, reprint, p. 16 f *.

therefore in my opinion the Texas deposits must rather be assigned to the Permo-Carboniferous.[1]

In 1891 came Dr. C. A. White's description of "thirty-two species of invertebrates . . . . . from the Texan Permian," of which four Cephalopods belonging to the family *Ammonoidea* were recognized as new. It was stated that two of these types, *Waagenoceras Cumminsi* and *Popanoceras Walcotti*, "are so generally regarded as indicating the Mesozoic age of the strata containing them that if they alone and without any statement of correlated facts had been submitted to any paleontologist he would not have been warranted in referring them to an earlier period than the Trias if he had followed the usually accepted standard of reference."[2]

In conclusion Dr. White stated that "The evidence upon which the Texan strata have been referred to the Permian is fuller than that which has been adduced with regard to any other North American strata that have been so referred. That is, the evidence both of the vertebrate and invertebrate fossils is in favor of such reference, and the difference in the character of the strata from those of the underlying Coal-measures, although not great, is conveniently distinguishable;"[3] while he was inclined to consider the Texan Permian as of younger age than the Indian and Sicilian strata containing the commingled Mesozoic and Carboniferous forms which were described by Professors Waagen and Gemmellaro.

Waagen correlated the "Red sandstones and shales of Texas, with many remains of Vertebrates, *Amphibia* and *Reptilia* and *Goniatites Baylorensis*, *Hyattoceras Cumminsi*, *Medlicottia Copei* and *Popanoceras Walcotti*" with the "Weissliegendes and marl slate" which he put at the base of the magnesian limestone, that formed the upper division of his Permian system.[4]

Marcou stated "It is certain that the Wichita division belongs

[1] *Mém. Acad. Imp. Sciences St. Pétersbourg*, VII[e] Sér., t. XXXVII, No. 2, 1889, p. 93. Also see the correlation of the Texas deposits as shown in Table C, p. 94.

[2] *Bull U. S. Geol. Surv.*, No. 77, p. 31. [3] *Ibid.*, p. 38.

[4] *Mem. Geol. Surv. India, Palæ, India*, ser. xiii, "Salt-Range Fossils," Vol. IV, Pt. II, "Geological Results," 1891. Tabular View showing the relations of the Salt-Range Upper-Palæozoic strata to the deposits of other countries, op. p. 238.

to the Dyas (Permian)"[1]; while in considering the list of fossils given by Cummins he said: "It is a fauna related with the Russian fauna of the Artinsk beds, and may be considered as the American representative of a part of the Russian Dyas (Permian)."[2]

Professor James P. Smith stated that "the Ammonite-bearing beds of northern Texas, described by Dr. C. A. White . . . . . belong above the Artinsk stage, and in the true Permian, and are probably of the same age as the middle division of the *Middle Productus* limestone of the Salt Range [India]."[3]

Dr. Keyes in discussing the parallelism between the Texas and Kansas beds said, "The Double Mountain beds are, in a broad way, manifestly approximately equivalent to Cragin's Cimarron series. This leaves a considerable part of the Clear Fork beds representing the Chase and Marion of Kansas."[4] Professor de Lapparent considered that in northern Texas the Uralian with *Productus cora* and *Athyris subtilita* is succeeded conformably by 300 meters of sandstones and shales, occasionally calcareous, in which the red color predominates, the base of which appears to belong in the Artinsk.[5] He stated that the red gypsiferous beds with *Pleurophorus* which in the western part of Texas surmount the Wichita formation belong in the Upper Permian.[6] Finally, Dr. Frech puts the Wichita and Clear Fork beds in the Palaeo-Dyas and the Double Mountain beds in the Neo-Dyas[7] and states that the Ammonoids described by Dr. White — *Medlicottia Copei*, *Popanoceras Walcotti* and *P.* (*Hyattites*) *Cumminsi* have their nearest relatives in the marine Dyas of Sicily.[8]

Provisional correlation of the Kansas formations.—The above statements indicate clearly enough the differences in opinion among geologists more or less acquainted with the Upper Paleozoic formations of the Great Plains, regarding their correlation. It is to be noted, however, that there is a more general agreement regarding the Permian age of the Texas deposits, and if Professor

[1] *Amer. Geol.*, Vol. X, 1892, p. 370. [2] *Ibid.*, p. 371.

[3] JOUR. GEOL., Vol. II, 1894, p. 194; and see "Correlation Table" on p. 204.

[4] JOUR. GEOL., Vol. VII, 1899, p. 325.

[5] *Traité de Géologie*, 4th ed., 1900, p. 981. [6] *Ibid.*, p. 994.

[7] *Lethaea palæozoica*, Bd. II, 3 Lief., 1901, p. 514. [8] *Ibid.*, p. 515.

Cummins has correctly correlated the Fort Riley limestone with the Texas deposits it furnishes a strong argument in favor of referring the Upper Paleozoic formations of Kansas to the Permian.

Furthermore, the number of American geologists who believe that these Upper Paleozoic formations should be correlated with the Permian and given the rank of a period or system is probably still smaller than the number of those who would retain the name Permian but classify it as the upper series of the Carboniferous. The writer had hoped to carefully study the fossils of these formations and to present their complete evidence regarding these questions, but other duties have prevented the execution of this plan. It has appeared to me, however, that the weight of evidence favored correlating the upper formations with the Permian.

Whether the Permian should be assigned the rank of a system coördinate with the Carboniferous or regarded as the upper subdivision of it is not quite clear, and the line of division between the Permian and the Carboniferous is in doubt, as indicated on the chart p. 730. The opinions of some of the leading European students of the Upper Paleozoic, who regard the Permian as a distinct system and correlate certain American formations with it, has seemed to the writer sufficient authority for provisionally regarding it as a system, which was done in the table of classification opp. p. 704. It is probable, however, that the U. S. Geological Survey will retain the name Permian, but will classify it as the last series of the Carboniferous system.

Conclusions of Dr. Keyes.— No one has, perhaps, insisted as strenuously as Dr. C. R. Keyes that the name Permian should be dropped from American geology. In 1897 he attended the sessions of the International Congress of Geologists at St. Petersburg and participated in the excursions to the Carboniferous and typical Permian of Russia. Later he prepared a paper on the "American homotaxial equivalents of the original Permian," and quotations from this cannot be regarded as from one favoring the retention of the name "Permian." Regarding the lithologic features Dr. Keyes said :

The original Permian strata are indistinguishable, lithologically, from the so-called Permian of Kansas. In both there are the same gray and variegated sandy shales and marls, passing locally into sandstones, that are often copper-bearing. Occasionally there are present thin bands and beds of buff earthy limestone. Gypsum is abundantly developed in the beds and interspersed everywhere through the rocks. Saline shales are of not infrequent occurrence. On both continents all these pass upward into "Red Beds" that are almost destitute of fossils.

And in another paragraph is a striking statement that "In the Russian district one finds it difficult to imagine that he is not wandering through some part of Kansas. Only the presence of the Russian peasant or sudden contact with a village of the steppes dispels the illusion."

Secondly, under the heading, "Range of faunas," Dr. Keyes reported as follows regarding the fossils:

The succession of faunas appears to be essentially the same in the Russian Carboniferous and Permian as in the Mississippi valley. The composition of each of the faunas is also strikingly comparable. The most noteworthy feature of the organic remains, viewed as a whole, is the gradual replacement of a purely marine type by a shore and brackish water phase, as the change from open sea to closed water conditions took place, and finally to those in which life could not exist. The most prominent characteristic of the biotic change from a Carboniferous phase to a Permian one seems to be the replacement of a predominantly brachiopod fauna by one in which lamellibranchs formed the preponderant element.[1]

While in another article Dr. Keyes said: "In lithological and faunal characters the rocks are so nearly alike that it is difficult to fancy that in the Urals one is on the opposite side of the earth from our Iowa and Kansas beds."[2]

Under the general heading, "Comparison of the Russia and Mississippi Valley Carboniferous," and subheading, "Stratigraphic parallelism," Dr. Keyes stated that "In Russia and in the Mississippi valley the general geological sections of the Upper Paleozoic are remarkably alike. The basins occupied by these rocks are very nearly of the same size. As already stated in the first-mentioned area, the Permian very greatly predomi-

[1] JOUR. GEOL., Vol. VII, 1899, p. 334.

[2] "Permian Rocks of Eastern Russia," in *Proc. Iowa Acad. Sciences*, Vol. VI, 1899, p. 231.

nates as the surface rock; in the last-named, the Coal-measures."[1] While the above paragraph is followed by the following "Comparison of general sections" in Russia and the Mississippi valley, which may evidently be regarded as Dr. Keyes's idea of the correlation of the upper Paleozoic rocks of the central United States and Russia.

Russia.	Character of Terranes.	Mississippi Valley.
Tartaran, Permo-Trias, or Upper Permian, P_3	Shales and marls, red and variegated, shaly sandstones; fossils rare; "Red Beds"	Cimarron Series
Middle Permian, P_2	Limestones, some dolomitic, separated by calcareous marl	(Marion li.)
Lower Permian, P_1-b	Shales (only 200 feet thick in Kama Valley)	——— ? } Series
Upper Permo-Carboniferous (base of original Permian) CP_c	Limestone, heavy dolomitic	(Chase li.)
Artinsk, CP	Shales, sandstones, some thin limestones	(Neosho) (Cottonwood) (Wabaunsee) } Series
Upper Carboniferous, C_3	Limestones and shales, highly fossiliferous	Missourian Series[2]

Finally, in his "Recapitulation" it is stated "That while we have in America a great succession of deposits identical in all essential respects to the original Permian of Russia, the two great basins merely had similar histories that are not necessarily connected and doubtless were wholly independent of each other and unrelated."[3]

Dr. Keyes's description and comparison of rocks and faunas apparently support the correlation of the Upper Paleozoic of the Great Plains with the Permian of Russia, providing one follows

[1] Jour. Geol., Vol. VII, 1899, pp. 331, 332.

[2] *Ibid.*, p. 332; *Proc. Iowa Acad. Sciences*, Vol. VI, p. 230.

[3] Jour. Geol., Vol. VII, p. 341; *Proc. Iowa Acad. Sciences*, Vol. VI, p. 231.

the rules of correlation generally observed by geologists.[1] The evidence is apparently about as conclusive as for other systems in this country which are correlated with the Carboniferous, Devonian, or Silurian of Europe. Apparently the main point of Dr. Keyes' contention is "That [the] Permian, as originally proposed, applies to a provincial series, and, according to our usual standard, has, at best, a taxonomic rank below that of system."[2] Yet he states it is probable that its main subdivisions will be elevated "to the rank of series," which, instead of causing the name Permian to be dropped, as he suggests, will more probably leave it with the rank of a system as originally defined by Murchison. A geologist familiar with the Kansas formations wrote as follows concerning the provincial series question: "Grant, as Keyes maintains, that Permian is the name of a provincial series, then where a similar series is found with similar fossils the same name ought to be given. All our names were names of provincial series at first. What was Devonian but the name of a series of rocks in Devonshire, England? When found in New York, by this argument, they should be called New Yorkian or some other American name."

The conclusions of Dr. Frech.— On the other hand, the conclusions of Dr. Fritz Frech, the eminent professor of geology and paleontology in the University of Breslau, may be considered. He has carefully studied, both in the field and laboratory, the Permian of Germany and Russia and examined in the field the Permian of the United States, at least as shown in the Grand Canyon and near Salt Lake City, Utah.[3] Dr. Frech gives these rocks the rank of a system, which is also the usage of Dr. Kayser, of the University of Marburg,[4] but instead of Permian he

[1] For instance, if his account be compared with the list of physical and biotic methods of correlation given by Professor Gilbert at the Washington meeting of the International Congress of Geologists, it will be seen that several of the methods are fulfilled (Congrès Géologique International, *Compte Rendu*, 5me session, Washington, pp. 68, 69).

[2] *Loc. cit.*, p. 341; and p. 231.

[3] See *Congrès Géologique International, Compte Rendu*, 5me Ses., Washington, 1891, 1893, p. 481; and *Lethaea palæozoica*, Bd. II, 3 Lief., 1901, p. 515.

[4] See *Text-Book of Comparative Geology*, by E. KAYSER, translated and edited by Philip Lake, 1893, p. 164.

uses the later name of Dyas proposed by Marcou on account of the sharply marked separation of the system into two divisions in Germany.

Dr. Frech's classification of the Upper Paleozoic of Kansas is as follows:

Upper Dyas	Red shales and clays.
	Marion.
Lower Dyas	Chase.
Transition to Carboniferous (distinct line fails.)	Neosho.
	Cottonwood beds.
Upper Carboniferous	Wabaunsee.[1]

Later Dr. Frech reviewed Professor Cragin's classification of the Permian, and termed the Cimarron series the "Neo-Dyas," and the Big Blue series the "Paleo-Dyas."[2] He stated that the Dyas equaled the Permo-Carboniferous plus the Permian of many authors, and that by general agreement at the St. Petersburg International Congress of Geologists the names Paleodyas (=Permo-Carboniferous) and Neodyas (=Zechstein) are employed.[3]

Under the discussion of the boundary line between the Dyas and Carboniferous Dr. Frech said: The dividing line between the Carboniferous and Dyas formations cannot be drawn with full certainty in every region, since especially in the Dyas the development of the local flora is nearly always the rule, and decisive differences do not exist in the Brachiopod fauna.

Yet an agreement seems to be gradually forming everywhere. . . . . Where the characteristic Dyas bivalves (*Pleurophorus*, *Schizodus*, *Bakewellia*, *Pseudomonotis*) appear in masses (Kansas), there cannot be any doubt about the dividing line.[4] Under the description of the Dyas of the northern hemisphere and the Arta stage of Russia, as Dr. Frech prefers to call the Artinsk, he said: That the animal remains of the Permo-

[1] *Lethaea palæozoica*, Bd. II, 2 Lief., 1899, p. 378, as translated above.

[2] *Ibid.*, 3 Lief., 1901, p. 514. [3] *Ibid.*, p. 453 f.

[4] *Ibid.*, pp. 490, 491. I am greatly indebted to Charles W. Mesloh, associate professor of Germanic languages and literatures in the Ohio State University, who very kindly translated for me several pages of Dr. Frech's description of the Dyas.

Carboniferous are in general more nearly related to the Carboniferous than the Zechstein, finds its explanation in the poverty of the species of the inland seas. The Arta stage occupies a large space on the western slope of the Ural mountains from the Arctic ocean to the Kirghiz Steppe and the Donetz River, and was correctly classified with the Dyas by older investigators (Pander). The plant remains described by Schmalhausen speak quite decidedly for a comparison with the western Rothliegende[1] Murchison considered the Arta sandstone the Millstone grit, while the modern Russian authors mostly call it an intermediary stage from the Carboniferous to the Dyas, Permo-Carboniferous. If the latter assumption were correct, then the Cusel and Lebach strata would also have to be regarded as transitional from the Carboniferous to the Zechstein, *i. e.*, the most important and best known part of the formation would become a transition and only the equivalent of the German Zechstein would be designated as Permian.[2]

Usage of Russian geologists.—Among the recent Russian geologists who have described transitional deposits between the Carboniferous and Permian systems, may be mentioned the following: Krotow, who in 1888 described the Permo-Carboniferous and Permian on the western slope of the Urals in the region of Tscherdyn and Solikamsk.[3] Th. Tschernyschew, in 1889, described the Permo-Carboniferous of the western slope of the central Urals, which he lettered C P, and gave as composed of the Artinsk (C Pg), and superjacent Dolomitic limestone (C Pc), the latter forming the base of Murchison's Permian system.[4] Krasnopolsky, the same year, described the Permo-Carboniferous and Permian deposits of another portion of the western Urals,[5] which was followed two years later by a further description.[6] Stuckenberg, in 1890, described the Permo-Carboniferous of another region, which he gave as composed in ascending order

[1] *Ibid.*, pp. 493, 494. [2] *Ibid.*, p. 493, f. 2.

[3] *Mém. Comité Géologique*, Vol. VI, pp. 553–9.

[4] *Ibid.*, Vol. III, No. 4, Blatt 139, pp. 356–66.

[5] *Ibid.*, Vol. XI, No. 1, Blatt 126, pp. 506–18.

[6] *Ibid.*, No. 2, 1891, pp. 28–30.

of the Artinsk and Kungur stages.[1] Sibirzev, in 1896 carefully described the Permian deposits near Nishny-Novgorod on the Volga, together with those of the Permo-Carboniferous farther to the west;[2] while Stuckenberg two years later described in a similar manner the Permo-Carboniferous and Permian formations of the Kama basin.[3]

Since then Dr. Keyes has very clearly summarized the Russian classification of the Upper Paleozoic terranes of eastern Russia in the following table:[4]

Terrane.	Symbol.	Character.
Tartaran	PT or P_3	Shales and marls, "Red Beds," very few fossils.
Zechstein (in part.)	P_2	Marls, limestones, and sandstones.
.....	Pb	Sandstones, shales, and marls with nodular limestones.
.....	C Pc	Dolomitic limestones (base of Murchison's Permian).
Artinsk	C Pg	Shales, shaly sandstones. This and next terrane above are called Permo-Carboniferous.
.....	C_3	Limestones.

Dr. Keyes states that following "the so-called true Carboniferous of the Urals . . . . are the transition faunas to the Permian, according to the Russians, and by them called Permo-Carboniferous. The two members which comprise it contain, as pointed out by Tschernyschew, very nearly the same organic forms, consisting largely of lamellibranchs, gasteropods, and brachiopods. The lower terrane, termed the Artinsk is notable for the ammonites that are found in it, which the author just mentioned compares with those lately found in the Texas Permian. . . . .

"The bottom terranes of the Permian, as now recognized by the members of the Russian geological survey, present a great paucity of fossils. The forms are chiefly lamellibranchs, yet in some layers are fragmentary plants.

"The median part of the Permian carries what has been regarded as the typical German Zechstein fauna.

[1] *Ibid.*, Vol. IV, No. 2, Blatt 138, pp. 111–14.

[2] *Ibid.*, Vol. XV, No. 2, Blatt 72, pp. 242–65.

[3] *Ibid.*, Vol. XVI, No. 1, 1898, pp. 309–21.

[4] JOUR. GEOL., Vol. VII, 1899, p. 330.

"About the upper terrane there is much dispute as to age. The Russian geologists are about equally divided. Amalitzky considers it Permian. By others it is regarded as Triassic. Fossils occur rarely. Those found are chiefly lamellibranchs."[1]

OPINIONS OF OTHER EUROPEAN GEOLOGISTS.

There are other noted European geologists, however, whose conclusions are in general accord with those of Dr. Frech.

Waagen, in his magnificent work on the geological classification of the Upper Paleozoic rocks of the Salt-Range in northern India, ranked the Permian as a system which he divided into the three following groups, arranged in ascending order: Permo-Carboniferous, Rothliegendes and Magnesian limestone. He published a table showing the correlation of the Upper Paleozoic strata of the Salt-Range with similar deposits of other countries on which the "red sandstones and shales of Texas," containing vertebrates and invertebrates which have been described by Cope and White, were correlated with the lower part of the Magnesian limestone, or upper group of his Permian system. The "limestones and shales, with *Pseudomonotis hawni* (——*speluncaria*) of Kansas, red gypsum beds of Texas"[2] were regarded as equivalent to the remaining portion of the Magnesian limestone group and consequently represent the upper part of the Permian system.

De Lapparent, in the last edition of his comprehensive treatise of geology, gives the Permian the rank of a system[3] to the lowest stage of which, the Artinskien or Autunien, he refers the Neosho, Chase and Marion terranes of central Kansas. It is stated that it would be difficult to class elsewhere than in the Artinskien, the Neosho and the Chase, although there may be a doubt regarding the correlation of the Marion.[4] On his table of "Synchronism of Permian assises," beds with *Pleurophorus* and with *Pseudomonotis* of Kansas are given as in the Thuringien or Upper Permian stage,[5] while on the following page it is stated

[1] *Ibid.*, pp. 330, 331.

[2] *Mem. Geol. Surv. India, Palæ.*, India. Series 13, Salt-Range Fossils, Vol. IV, Pt. II, Geol. Results, Calcutta, 1891, op. p. 238.

[3] *Traité de Géologie*, 4th ed., Pt. II, 1900, pp. 759–963.

[4] *Ibid.*, pp. 980–1. [5] *Ibid.*, p. 993.

that in the Upper Permian is, perhaps, also the horizon of the upper limestones and shales of Kansas with *Pseudomonotis Hawni*, which surmount 75 meters of variously colored shales and marls, with gypsum (assise de *Marion* de M. Prosser).[1]

It is to be noted, however, that de Lapparent is in error in correlating the sandstones and shales of Nebraska with the lower part of the Penjabien or Saxonien, which he classifies as the Middle Permian.[2] Such a classification puts the Nebraska City beds at least above the Neosho and Chase, as is clearly indicated on his table of synchronism, while as a matter of fact it has been shown by Dr. Beede and the writer that they are probably equivalent "to the Topeka limestones and Osage shales of the Kansas river section, which form the upper part of Professor Haworth's Shawnee formation of the Upper Coal-measures."[3] The rocks included between the top of the Shawnee formation, which is marked by the base of the Burlingame limestone, and the top of the Chase stage have an approximate thickness of 950 feet in eastern central Kansas, which gives an idea of the stratigraphic error when the Nebraska City beds are assigned to a position above the Chase stage.

In discussing the rank of the Permian de Lapparent wrote: The marine types of the Permian, scarcely known until recent years, show in Asia as in the United States greater and greater development. Finally, the well confirmed discovery of Ammonites with arborescent septæ gives to the pelagic fauna of the period a special character, at the same time that by the first appearance of true reptiles the terrestrial fauna shows a higher order than that of the preceding period. Therefore, we, agreeing with the excellent arguments of Neumayr in his *Erdgeschichte*, raise to the rank of system this last division of Primary time.[4]

Finally, from among the other famous European geologists who rank the Permian as a system and have written in support

[1] *Ibid.*, p. 994. [2] *Ibid.*, pp. 986–93.

[3] JOUR. GEOL. Vol. VII, Aug., 1899, p. 346. Also, see PROSSER, *ibid.*, Vol. V, March, 1897, p. 148; and BEEDE, *Kan. Univ. Quart.*, Vol. VII, Oct., 1898, Series A, p. 231; and *Trans. Kan. Acad. Science*, Vol. XVI, 1899, p. 70.

[4] *Ibid.*, p. 964.

of this proposition may be mentioned the following: Credner,[1] Prestwich,[2] Neumayr,[3] Sir Archibald Geikie,[4] Ed. Suess,[5] and Karl v. Zittel.[6]

CHARLES S. PROSSER.

COLUMBUS, OHIO,
June, 1902.

The question as to whether the Alma limestone should be substituted for the Cottonwood limestone on account of the earlier name of Cottonwood Creek beds in Texas was submitted to the U. S. Geological Survey Committee on Formation Names and under date of October 29, 1902, Dr. C. Willard Hayes has sent me the following report of the committee:

This committee approved the name *Cottonwood limestone* at its meeting March 29, 1902, and at that time considered the priority of *Cottonwood Creek beds, Texas.* It decided at the time that, although the latter name had priority of usage, it probably was not a clearly-defined formation but merely a bed of unmapable dimensions. Also that inasmuch as *Cottonwood Creek beds* has not occurred in literature since its first usage in 1893, and whereas *Cottonwood* (*Cottonwood Falls*) *formation* has been used thirteen times since its first usage in 1894, the latter name has acquired a place in literature on the grounds of prescription. The committee therefore decided to adhere to its former decision in favor of *Cottonwood limestone.*"

In compliance with the above decision the writer withdraws the name Alma limestone and retains Cottonwood limestone as the name of the Kansas formation.

C. S. P.

October 31, 1902.

[1] *Elemente der Geologie*, 6th ed., 1887, pp. 382–507.

[2] *Geology, Chemical, Physical and Stratigraphical*, Vol. II, 1888, pp. 8–131.

[3] *Erdgeschichte*, Bd. II, 1890, pp. 37–199.

[4] *Text-Book of Geology*, 3d. ed., 1893, "The Geological Record," op. p. 679 and p. 841.

[5] *La face de la terre*, translated by EMM. DE MARGERIE. T. II, 1900, p. 407.

[6] *History of Geology and Palæontology*, translated by MARIA M. OGILVIE-GORDON, 1901, p. 453.